UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte PAI-HUNG PAN, MARTIN C. ROBERTS,
GURTEJ S. SANDHU,
WEIMIN LI, CHRISTOPHER W. HILL
and VISHNU K. AGARWAL

Appeal No. 2005-0323
Application No. 09/577,835

HEARD: APRIL 7, 2005

Before BARRETT, DIXON, and LEVY, Administrative Patent Judges.

LEVY, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 25-30, which are all of the claims pending in this application.

BACKGROUND

Appellants' invention relates to the passivation of sidewalls of a word line stack. An understanding of the

invention can be derived from a reading of exemplary claim 25, which is reproduced as follows:

25. An integrated circuit comprising:

a semiconductor substrate;

a gate dielectric film disposed on a surface of the substrate;

a gate electrode stack disposed on the gate dielectric film, wherein the stack includes a plurality of layers located over the gate dielectric film and forms continuously vertical sidewalls; and

a plurality of composite spacers each extending continuously from a bottom to a top of said continuously vertical sidewalls,

wherein each of said composite spacers further comprises a nitride spacer vertically staked above an oxide spacer,

said oxide spacer extending along the bottom of said continuously vertical sidewalls to an intermediate point in between the top and the bottom of said continuously vertical sidewalls, and

said nitride space spacer [sic] extending from the intermediate point to the top of said continuously vertical sidewalls.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

Mogami	5,656,519	Aug. 12, 1997
Bai et al. (Bai)	5,861,340	Jan. 19, 1999
Gardner et al. (Gardner)	5,899,721	May 4, 1999

Claims 25-27 and 30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Gardner in view of Mogami.

Claims 28 and 29 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Gardner in view of Mogami and Bai.

Rather than reiterate the conflicting viewpoints advanced by the examiner and appellants regarding the above-noted rejections, we make reference to the examiner's answer (Paper No. 28, mailed March 9, 2004) for the examiner's complete reasoning in support of the rejections, and to appellants' brief (Paper No. 26, filed November 17, 2003) and reply brief (Paper No. 29, filed May 10, 2004) for appellants' arguments thereagainst. Only those arguments actually made by appellants have been considered in this decision. Arguments which appellants could have made but chose not to make in the brief have not been considered. See 37 CFR § 41.37(c)(1)(vii).

OPINION

In reaching our decision in this appeal, we have carefully considered the subject matter on appeal, the rejections advanced by the examiner, and the evidence of obviousness relied upon by the examiner as support for the rejections. We have, likewise,

reviewed and taken into consideration, in reaching our decision, appellants' arguments set forth in the briefs along with the examiner's rationale in support of the rejections and arguments in rebuttal set forth in the examiner's answer.

Upon consideration of the record before us, we affirm. We observe at the outset appellants' assertion (brief, page 4) that claims 25-30 stand or fall together. However, because appellants are entitled, procedurally, to consideration of at least one claim for each different ground of rejection, we select claim 25 as representative of claims 25-27 and 30; and select claim 28 as representative of claims 28 and 29.

We begin with the rejection of claims 25-27 and 30 under 35 U.S.C. § 103(a) as being unpatentable over Gardner in view of Mogami. In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the examiner to establish a factual basis to support the legal conclusion of obviousness. See In re Fine, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In so doing, the examiner is expected to make the factual determinations set forth in Graham v. John Deere Co., 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have been led to modify the prior art or to combine prior art references to arrive

at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. Uniroyal, Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir. 1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985); ACS Hosp. Sys., Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the examiner are an essential part of complying with the burden of presenting a prima facie case of obviousness. Note In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). If that burden is met, the burden then shifts to the applicant to overcome the prima facie case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole. See id.; In re Hedges, 783 F.2d 1038, 1039, 228 USPQ 685, 686 (Fed. Cir. 1986); In re Piasecki, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); and In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976).

The examiner's position (answer, pages 3 and 4) is that Gardner discloses the claimed integrated circuit including the composite spacers extending continuously on the vertical sidewalls, wherein each of the spacers comprises a nitride spacer

vertically stacked above an oxide spacer, at an intermediate point, as shown in figure 9. The examiner adds (answer, page 4) that Gardner does not teach that the spacer structures extend from a bottom to over a top of the continuously vertical sidewalls. To overcome this deficiency of Gardner, the examiner turns to Mogami for a teaching of a spacer structure extending from a bottom to over the top of the continuously vertical sidewalls of a gate electrode stack, as shown in figure 8F. The motivation provided by the examiner (id.) is that the modification would have been obvious to an artisan in order to prevent a short circuit between the source/drain regions and the gate electrode stack.

Appellants assert (brief, page 4) that the examiner has failed to establish a prima facie case of obviousness. It is argued (brief, page 5) that as shown in figure 9, the composite spacer fails to extend continuously from a bottom to a top of said continuously vertical sidewall of metal silicide layer 122. Appellants acknowledge (brief, page 6) that in Mogami, the oxide sidewall is higher than the top of the gate electrode stack, which electrically isolates the gate electrode from the source/drain regions, which is advantageous in preventing short circuits between the gate electrode stack and the source/drain

regions. However, appellants argue to the effect that (brief, page 8) Mogami does not disclose a composite sidewall structure that extends from a bottom to a top of the continuously vertical sidewalls. It is argued (id.) that there is no motivation to combine the teachings of Gardner and Mogami because Gardner already includes a mechanism (figure 9) for avoiding short circuits between the gate electrode and the source/drain regions. It is further argued (id.) that if the oxide portion of Gardner were lengthened, there would be no need for the nitride portion of the spacer in Gardner. Additionally, appellants argue that combining the teachings of Gardner and Mogami would not result in the claimed invention because the resultant structure would have an oxide layer that runs from at least a bottom of the stack to above a top of the sidewall.

The examiner responds (answer, page 5) that with regard to appellants' assertion that there is no motivation to combine the teachings of Gardner and Mogami, that in Mogami, the spacer structure extends above the top surface of the gate stack, and that therefore, the silicide material on top of the gate conducting layer cannot bridge between the gate stack and the source/drain region, resulting in prevention of a short circuit between the gate stack and the source/drain region. With regard

to appellants' assertion that upon modifying Gardner in view of Mogami, the result would include oxide spacers and not a composite spacer, the examiner asserts (answer, page 6) that Gardner already teaches the composite spacer, and that Mogami is merely relied upon to show the shape of the spacer which extends above the surface of the gate. The examiner adds that the test [for obviousness] is what the combined teachings of the references would have suggested to an artisan.

Appellants respond (reply brief, page 2) that there is no motivation to extend the nitride portion of the composite spacer so that it extends to the top of the continuously vertical sidewalls of the gate electrode stack. It is argued that the examiner's proposed combination of Gardner and Mogami appears to be based upon impermissible hindsight, and that without using the present application as a guide, an artisan would not have been motivated to make the modifications to the Gardner electrode in the manner suggested in the final rejection.

From our review of the record, we find Gardner to be an excellent reference. As shown in figure 9 of Gardner, the gate electrode is topped by a silicide layer 122. Sidewall composite layers 114 and 116 are in the form of a nitride layer on top of an oxide layer, with the continuous sidewalls extending from a

bottom of the gate stack to the top. The figure appears to show the sidewalls extending virtually up to the top of the gate stack. Although the drawing shows silicide layer 122 extending slightly above the top of the composite sidewall, we note that the drawings are not to scale. In addition, the silicide layer is very thin, perhaps in the range of several hundred angstroms. We observe the statement in appellants' specification (page 12) that:

> To provide spacers that extend to about the same height as the resulting stack 10, the nitride spacers 22 can be over-etched slightly during formation of the spacers (*see* FIG. 8). The extent of the over-etching that is desirable will depend on the amount of the oxide layer 20 that is to be subsequently removed prior to the source/drain reoxidation. The amount of over-etching of the nitride spacers 22 can be controlled so that following removal of part of all of the oxide layer 20 the top of the stack 10 and the top of the nitride spacers 22 are at about the same height (*see* FIG. 9). (Underlining added)

However, although it appears that the sidewalls may extent to the top of the gate stack, to the extent disclosed by appellants, because the examiner and appellants have taken the position that the sidewalls of Gardner do not reach the top of the continuously vertical sidewalls of the gate stack, we decline to overturn the common interpretation of Gardner advanced by both the examiner and appellants. We note that had we found Gardner to disclose

spacers extending to the height of the vertically extending sidewalls of the gate stack, we would have found that Gardner anticipated appellants claims.

Turning to Mogami, we find that from Mogami's teaching of having spacers extend to a point above the top of the vertically extending sidewalls of the gate stack, in order to prevent short circuit between the silicide layer on the gate electrode and the source/drain regions, that an artisan would have been motivated to increase the height of the sidewall the difference, if any, necessary to reach the top of the sidewall. We observe that in Mogami, the spacer extends above the top of the vertically extending sidewalls of the gate stack, and do not stop at the top. However, from the "comprising" language of the claims, we find no language in the claims that would preclude the spacers from extending above the top of the sidewalls of the gate stack.

Turning back to Gardner, we recall that the spacers 114, 116 extend close to the top of the silicide layer. With this in mind, we return to Mogami. Mogami discloses that as MOS devices have scaled down to improve performance, the gate length of the gate electrode has been shortened and the junction depth of the source/drain diffusion regions has been shallowed, resulting in decreased drain current. To suppress the decrease in drain

current, a prior art method has suggested forming a metal silicide layer on the gate electrode and the source/drain diffusion regions, to reduce parasitic resistance. However, since the metal silicide layer on the gate electrode is as high as the sidewall insulating layer formed on the sidewall of the gate electrode, if the metal silicide layer is extremely grown, a short circuit may occur between the gate electrode and the source/drain regions (col. 1, lines 13-36). We find the teaching of the metal silicide layer being extremely grown to mean that the metal silicide layer is grown to a point that it extends above the top of the sidewall insulating layer formed on a sidewall of the gate electrode.

Mogami further discloses (col. 1, lines 37-63) that "the height of the metal silicide layer on the gate electrode layer is smaller than that of the sidewall insulating layer, so that the gate electrode layer is electrically isolated from the source/drain regions. Thus, no short circuit may be generated between the gate electrode layer and the source/drain regions." From Mogami's disclosure that it was known to make the height of the silicide layer smaller than the height of the sidewall insulating layer to prevent short circuiting between the gate electrode and the source/drain regions, we find that in Gardner,

we have the situation where the silicide layer 122 extends above the top of the sidewall spacers 114 and 116. Although Gardner takes the position (col. 3, lines 33-40) that "[t]he resulting metal silicide 122 has a relatively low resistivity and serves as a self-aligned contact region across source/drain regions 120 and gate conductor 104. Absent refractory metal upon the lower portions of the spacers, no silicide formation occurs at those portions. Consequently, silicide bridging between gate conductor 104 and source/drain regions 120 is less likely to occur," we find that as taught by Mogami, because the metal silicide layer extends above the top of the sidewall, that a short circuit can occur. Thus, an artisan, with the teachings of Gardner and Mogami before him/her, would be taught to extend the height of the sidewall spacers 114 and 116 to the top of the metal silicide layer; see for example figures 2F and 3E of Mogami.

We are not persuaded by appellants' assertion that neither reference teaches a composite sidewall spacer at the top of the gate stack because it is the teachings of the prior art as a whole that must be considered. Nor are we persuaded by appellants' assertion that there is no motivation to combine the teachings of Gardner and Mogami because even though Gardner discloses that the metal silicide layers result in less

likelihood of bridging between the gate conductor and the source/drain regions, we find from Mogami that if the top of the silicide layer is above the top of the sidewall spacers, that short circuiting can occur. In view of Mogami's recognition of this problem and disclosure of having the sidewall spacers above the top of the gate stack to prevent short circuiting, we find that an artisan would have been motivated to combine the teachings of Gardner and Mogami as advanced by the examiner. From all of the above, we are not convinced of any error on the part of the examiner, and find that the teachings of Gardner and Mogami suggest the language of claims 25-27 and 30. Accordingly, the rejection of claims 25-27 and 30 under 35 U.S.C. § 103(a) is affirmed.

We turn next to claim 28. The examiner's position (answer, pages 4 and 5) is that Gardner and Mogami do "not teach that the silicide layer is a refractory metal silicide layer and a diffusion barrier layer formed between the polysilicon layer and the silicide layer." To overcome this deficiency in Gardner and Mogami, the examiner turns to Bai for a teaching of "a semiconductor device comprising: a gate stack (222) including a polysilicon layer (204), a conductive diffusion barrier layer (206, a TiN layer) on the polysilicon layer and a refractory

metal silicide layer such as cobalt silicide, titanium silicide and platinum silicide." According to the examiner, the modification would have been obvious because the conductive barrier layer would prevent diffusion of silicon atoms into the polysilicon layer into the silicide layer. From our review of Bai, we are in agreement with the examiner's position. From the complete lack of any arguments as to claim 28 by appellants, we are not persuaded of any error on the part of the examiner. Accordingly, the rejection of claim 28 under 35 U.S.C. § 103(a) is affirmed. As claim 29 falls with claim 28, the rejection of claim 29 is affirmed.

CONCLUSION

To summarize, the decision of the examiner to reject claims 25-30 under 35 U.S.C. § 103(a) is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136 (a)(1)(iv)(effective September 13, 2004; Fed. Reg. 49960 (August 12, 2004); 1286 Off. Gaz. Pat. and TM Office 21 (September 7, 2004)).

AFFIRMED

LEE E. BARRETT
Administrative Patent Judge

JOSEPH L. DIXON
Administrative Patent Judge

STUART S. LEVY
Administrative Patent Judge

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